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41 items enclosed

MEMORANDUM FOR PRS (In-House Publication)

FROM: PROI (STINFO) 04 May 2001

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-SB-2001-109**
Shelley, J.S., "Alternative Processing to Electrodeposition to Form Thrust Chamber Structural Jackets"

SBIR Topic Submission **(Statement A)**
(Deadline: 10 May 01)

1. This request has been reviewed by the Foreign Disclosure Office for: a.) appropriateness of distribution statement, b.) military/national critical technology, c.) export controls or distribution restrictions, d.) appropriateness for release to a foreign nation, and e.) technical sensitivity and/or economic sensitivity.
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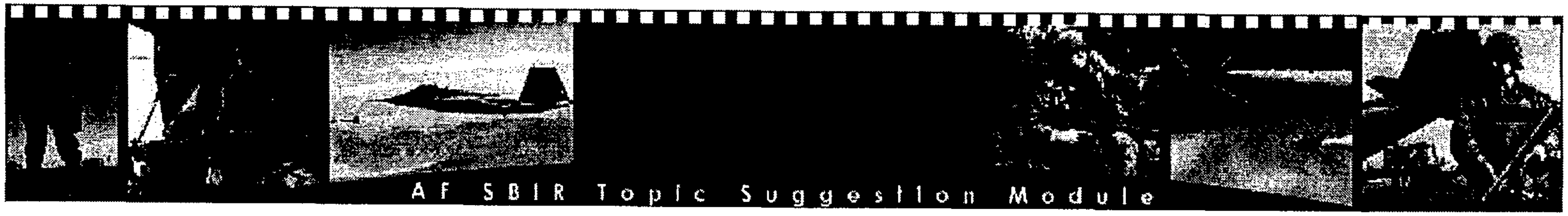
PHILIP A. KESSEL Date
Technical Advisor
Space and Missile Propulsion Division



TSM Help & References - includes a step-by-step Quick Reference for adding/editing topics

Comments Area | Printer Friendly Topic

Topic List

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Topic Type: TD
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Topic Title: Alternative Processing to Electrodeposition to form Thrust Chamber Structural Jackets
Category: Applied Research
DoD Crit Tech: Materials / Processes

Objective:

Identify, demonstrate, and develop a method of forming a liquid rocket engine thrust chamber structural jacket that is less expensive than electrodeposition and capable of applying "nanostructured" materials. Document and demonstrate cost and/or weight advantages over conventional electrodeposition (ED) of nickel.

Description:

The state-of-the-art in fabricating structural jackets for liquid rocket engine thrust chambers is electrodeposition of nickel. While the process forms the manifold connections in situ and bonds the nickel to the regeneratively cooled copper liner effectively, it is expensive and can take up to six months. This extremely slow process contributes to the thrust chamber costing over 11% of the total engine cost and 28% of the Combustion and Energy Conversion Devices (C&ECD) subsystem cost, as well as creating the longest lead time of any rocket engine component. The Integrated High Payoff Rocket Propulsion Technology (IHPRPT) program cost and weight reduction goals are forcing engine developers away from ED nickel for this component. Current ED nickel structural jackets are nearly 7% of overall engine weight. To reduce weight, more exotic materials such as particulate reinforced metal matrix composites (MMCs), ultrafine grained, and nanostructured nickel and aluminum are being developed for this application. Processing techniques for fabricating structures with varying cross sectional thicknesses, complex geometries, and large surface areas are needed. Innovative process techniques that can retain or develop appropriate microstructures in "nanostructured' materials or appropriately distribute particulate reinforcements in MMCs are being sought.

Phase I:

Consult with rocket engine manufacturers to identify candidate materials, material property requirements, and process requirements for liquid rocket engine thrust chamber structural jackets. Identify and describe a process for applying the candidate material(s) in the size and complexity required. Determine the effects of varying process parameters and determine the process improvements and modifications necessary to manufacture a full-scale thrust chamber jacket. Demonstrate the process on a suitable test article.

Phase II:

repeatedly (?)

Finalize the plan to develop the process as described in Phase I. Verify that the process can repeatablely create material with the required mechanical and physical properties. Modify the process as planed. Consult with rocket engine manufacturers to determine typical thrust chamber failure modes such as thermal cycling fatigue, liner debonding, and hydrogen embrittlement. Develop a test plan to investigate critical failure modes and design suitable test samples. Fabricate acceptable manufacturing technology demonstrators and test them according to plan. Develop the process, re-accomplish testing as required, and create a manufacturing plan.

Phase III Dual Use Applications:

Phase II and Phase III IHPRPT demonstrator engines, as well as NASA second and third generation shuttle programs, will require advanced thrust chamber designs to meet system requirements. Other industries, such as air-breathing propulsion and automotive industries, are beginning to investigate the use of "nanostuctured" materials and metal matrix composites. If affordable processing methods can be developed for these materials, many commercial industries would benefit.

Related References:

1. "Modern Engineering for Design of Liquid Propellant Rocket Engines", D.K. Huzel and D.H. Huang, AIAA (1992) chapters 1 and 4.
2. "Metal Matrix Composites for Liquid Rocket Engines", Journal of Metals, TMS (April 2001).
3. "Aluminum Composite Reduces Cost, Improves Performance," Advanced Materials & Processes, Vol. 152 (Oct. 1997), p. 7.
4. "Smarter Methods Allow Aluminides To Improve Engines," Advanced Materials & Processes, Vol. 152 (Oct. 1997), p. 14.

Keywords:

Thrust Chambers, nanostructured materials, metal matrix composites, manufacturing techniques, non-thermal processing, deposition processes